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TECHNICAL REPORT NUMBER 6

DESCRIPTIONS OF DIGITAL COMPUTER PROGRAMS

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Delaware Estuary Comprehensive Study

REPORT NUMBER 6

U.S. DEPARTMENT OF
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Public Health Service
Division of Water Supply and Pollution Control

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16. Abstracts The computer programs that were written for the Delaware Estuary Comprehensive Study and are presently being used by the study are described. The report on each program includes a brief description of its use and logic. This is augmented by simplified flow charts, a listing of necessary input data, the output obtained, a glossary for the identification of important variables and sub-routines, and a listing of the Fortran program.

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Delaware Estuary Comprehensive Study

Report Number 6

Division of Water Supply and Pollution Control
Region II , New York, New York

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service

DELAWARE ESTUARY COMPREHENSIVE STUDY

TECHNICAL REPORT NO. 6

DESCRIPTIONS OF DIGITAL COMPUTER PROGRAMS

This Technical Report, one of a series prepared by the staff of the Delaware Estuary Comprehensive Study, is for the information of interested agencies and individuals. Reports will be added to the series as developments from the various phases of the Study provide additional information that will be of value to others concerned with water pollution control.

Technical Reports:

1. Report on Analysis of the Diffusion Data in the Delaware River Estuary.
2. Estuarine Water Quality Management and Forecasting.
3. Minimizing Costs of Investment to Improve Water Quality: An Illustrative Problem.
4. Mathematical Model for Dissolved Oxygen.
5. On the Management of the Quality of Natural Water Systems.

DELAWARE ESTUARY COMPREHENSIVE STUDY

Descriptions of Digital Computer Programs

PREFACE

The conduct of the Delaware Estuary Comprehensive Study requires mathematical and data analyses for which digital computation is necessary. The purpose of this report is to describe the computer programs that were written for the Delaware Estuary Comprehensive Study and are presently being used by the Study.

However, more programs may be in use than are described in this report. As descriptions of such programs are completed, they will be appended to this report and noted in a revised Table of Contents.

The report on each program includes a brief description of its use and logic. This is augmented by simplified flow charts, a listing of necessary input data, the output obtained, a glossary for the identification of important variables and sub-routines, and a listing of the Fortran program.

DELAWARE ESTUARY COMPREHENSIVE STUDY

Descriptions of Digital Computer Programs

1. TRAFNIB, a general purpose program for the computation of the transfer functions of dynamic linear systems. It is written in FORTRAN 63 for the Control Data Corporation 1604 computer.

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1. GENERAL PROGRAM FOR TRANSFER FUNCTIONS (TRAFNIB)

INTRODUCTION

The purpose of this program is to determine how a one-dimensional water resource system with given hydrodynamic characteristics (flow, diffusion, reaeration, decay, etc.) reacts to the external influences affecting it. When a set of linear differential equations with constant coefficients can describe the system, the relationships between these external influences (inputs) and the environment's responses (outputs) are embodied in the transfer functions of the water resource system. In general, the transfer functions quantify the environment's responses (e.g., dissolved oxygen or biochemical oxygen demand concentrations) as attenuations of input amplitudes and shifts in input phases. The response to steady state (or constant) inputs may be computed with the general program or it may be found through a simplified program designated PRIN.

This report presents descriptions of the general transfer function program called TRAFNIB. For a discussion of how transfer functions may be used in water quality control, refer to (1), (2), (3), (4). These references include information on the derivation of the equations used to construct the transfer functions.

Outline of TRAFNIB

Figure One presents a simplified flow chart of the program and indicates the basic features of the computations. A major

sub-routine, PQA, is shown in Figure Two. As indicated in the references, the transfer function is a function of frequency (cycles per unit time, denoted as ω) and is specified in terms of its amplitude attentuation called $A_{ij}(\omega)$ and its phase shift called $FEE_{ij}(\omega)$. An $A_{ij}(\omega)$ function represents the amplitude attentuation of the response in the jth section as a function of the frequency of an input of unit amplitude in the i^{th} section. A $FEE_{ij}(\omega)$ function represents the phase shift in degrees, as a function of frequency, of the output in section j relative to an input in section i.

Both $A_{ij}(\omega)$ and $FEE_{ij}(\omega)$ are computed from the real part ($P_{ij}(\omega)$) and the imaginary part ($Q_{ij}(\omega)$) of the transfer function for an input in i and its response in j.

An additional set of functions is also computed in the program. These are known as the impulsive response functions of time denoted $k_{ij}(t)$ and they indicate how a transient input in a section i is responded to in section j.

From the flow chart in Figure 1, it is seen that the first step in the program is to set lower bounds of $A_{ij}(\omega)$ and $k_{ij}(t)$. When $A_{ij}(\omega)$ is less than TOLA, computation is stopped; this occurs either because of the distance between the input and the output sections or because values of ω used to calculate the functions are large enough to make $A_{ij}(\omega)$ insignificant. Since $k_{ij}(t)$ is not a function of ω, it must have its own limit; TOLKT, is used to stop computation when the maximum value of $k_{ij}(t)$ is less than TOLKT. This occurs as the distance between the input and output sections becomes large.

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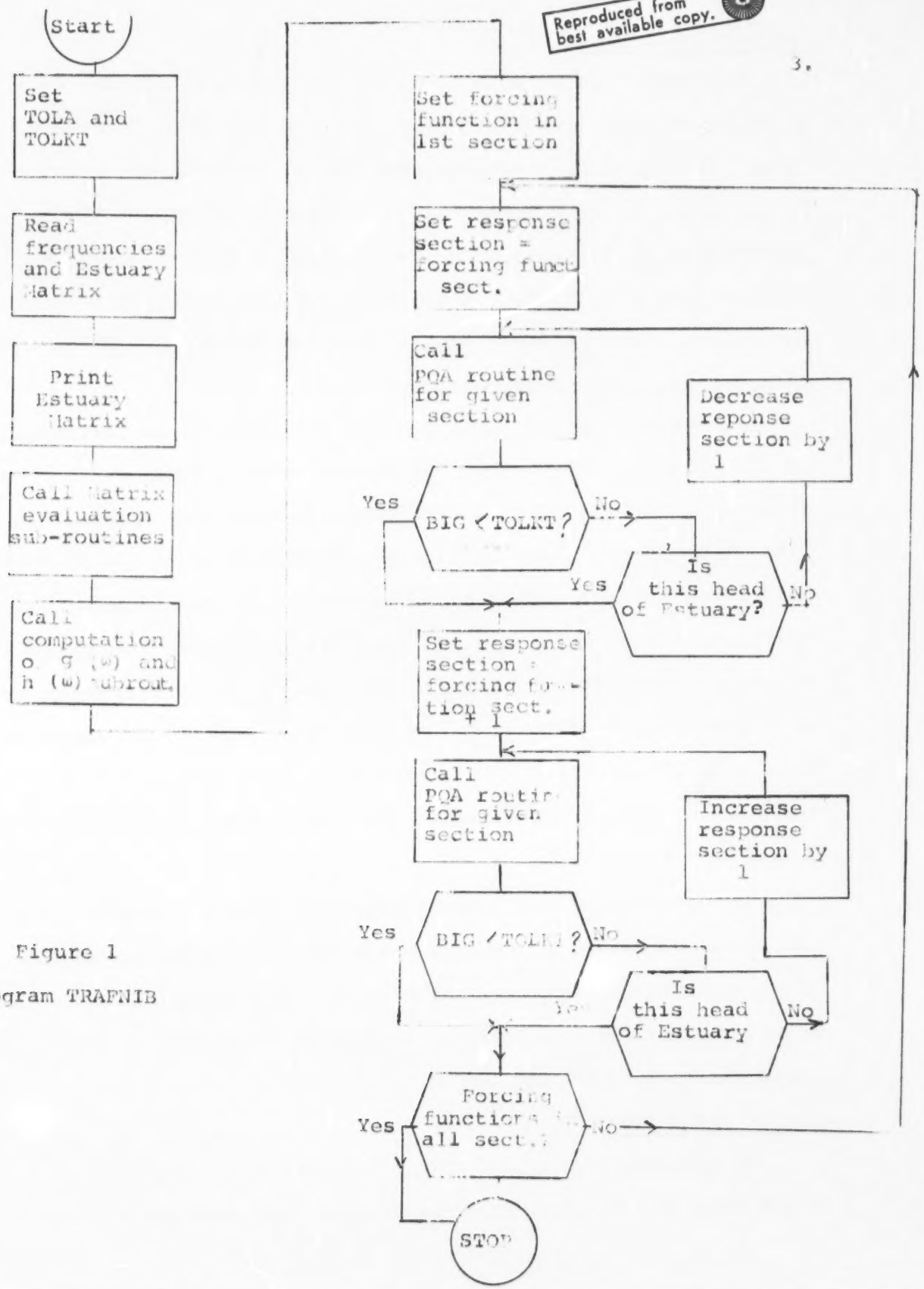


Figure 1

Program TRAFNIB

TRAFNIB INPUT DATA

The first set of input data to the program consists of a group of integers resulting in a range of frequencies from a lower limit of zero (mean response) to an upper limit of 2π (1460/365) or 25.2 cycles/year. These frequencies are expressable as 2π n/365 with n drawn from a set of integers ranging from 0 to 1,460. This range provides all the information that is necessary to quantify how $A_{ij}(\omega)$ and $FEE_{ij}(\omega)$ vary with increasing frequency.

The second set of input data to the program is designated as the Estuary Matrix. In the program listing which accompanies this report, the Delaware Estuary was divided into 30 sections. Each section was represented by coefficients which depend on such factors as the incoming freshwater flow, magnitude of turbulent diffusion, reaeration or decay coefficient, volume of the section and a parameter analogous to a mixing ratio. The coefficients may be computed with a desk calculator. These become the elements of the Estuary Matrix and formulas for their computation are given in (1) and (2).

In the general one-dimensional case (which includes the one-dimensional straight-run stream) the resulting matrix is tridiagonal with polynominals on the main diagonal. The input matrix is printed out to provide a check that the input data were read correctly.

USE OF INPUT DATA

In the next two steps of the program, there are operations on the input data to produce the information

necessary for use later in the program: the input matrix is inverted and the information is stored for use in the computation of the $g_{ij}(\omega)$ and $h_{ij}(\omega)$ functions in the main program, and the $e_{ij}(\omega)$ and $f_{ij}(\omega)$ polynomials in the PQA sub-routine.

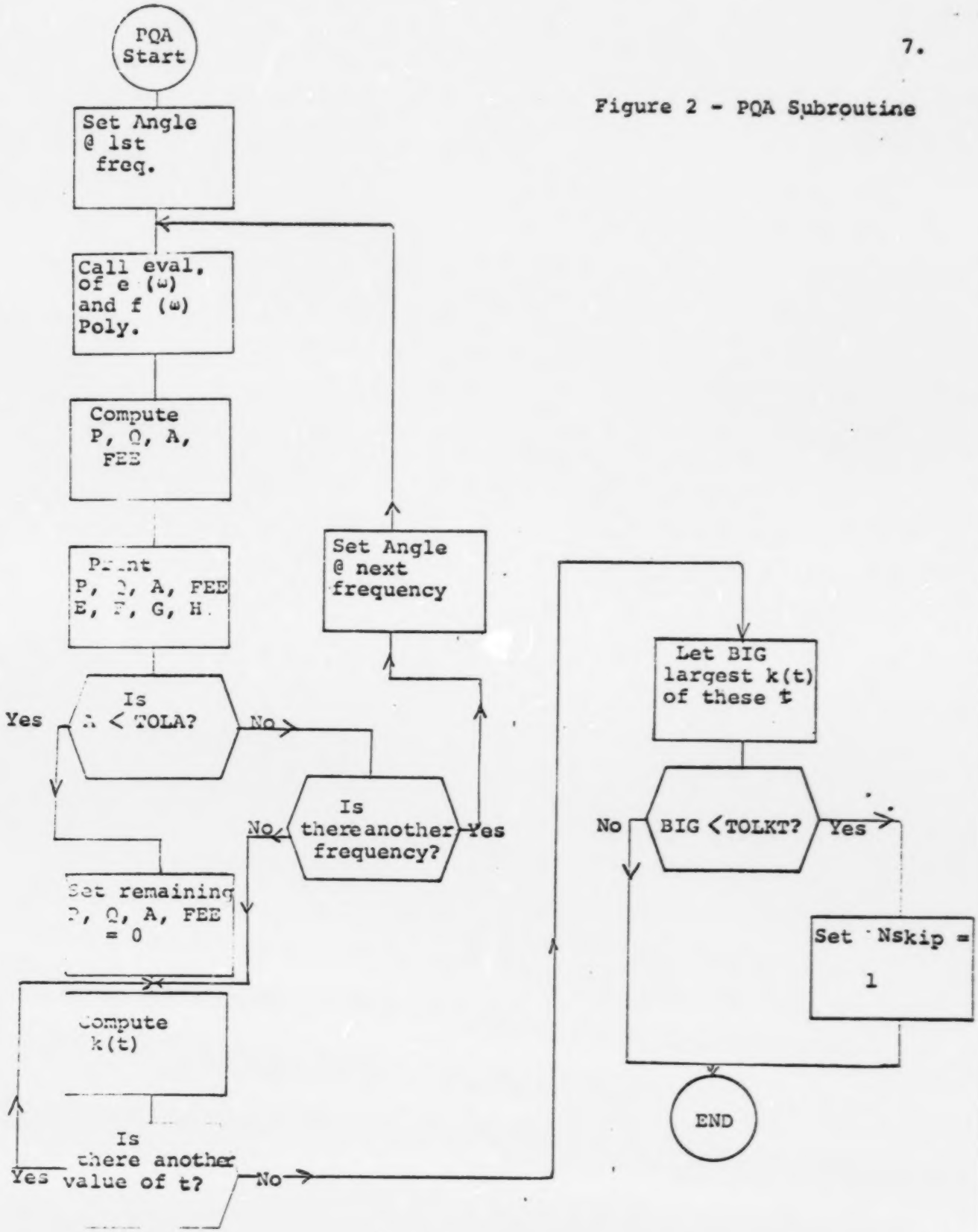
A unit amplitude forcing function (input) is now placed in the first section of the estuary. The response (output) section is set equal to the section in which the input is being applied, initially the first section. The PQA sub-routine is called and the transfer function is computed for an input in the first section and a response in the first section. This constitutes the beginning of the backward sweep; it computes the transfer function for the same section in which the input is placed. Then the sub-routine computes the response in the section which precedes (going upstream) the one in which the input is placed. Thus the response is now computed two sections upstream from the same input. Thus the backward sweep proceeds upstream until it is stopped either because the $k_{ij}(t)$ values fall under their tolerance or the head of the estuary is reached. Then a forward sweep is carried out. The transfer functions are computed for the responses in each section, beginning with the section just downstream from the input and then proceeding further downstream, until the mouth of the estuary has been reached or the $k_{ij}(t)$ functions become too small.

At this point in the computations, the input-output relationships in the form of transfer functions have been computed for an input in one section and responses in every section (where the responses are significantly large). A test must then be performed to determine whether the unit forcing function has been placed in all sections. If not, the unit amplitude is set as an input in the section just downstream from the one in which it had been placed just previously and the process (backward and forward sweeps) is repeated. In this manner, the responses in all sections due to inputs in all other sections is obtained.

Sub-routine PQA

Figure Two is a simplified flow diagram of this sub-routine. As indicated above, a set of input frequencies representing a sufficiently wide range has already been read in the main program, TRAFNIB. The ANGLE corresponding to the first frequency in the set is computed and the $e_{ij}(\omega)$ and $f_{ij}(\omega)$ polynomials are then formed. It should be noted that the g (ω) and h (ω) polynomials that are computed in the main program need be evaluated only once since they are independent of the location of the input or response section. However, $e_{ij}(\omega)$ and $f_{ij}(\omega)$ depend on the i^{th} input section and j^{th} response section. The coefficients for these polynomials were computed in the matrix evaluation sub-routines.

Figure 2 - PQA Subroutine



With the polynomials computed, $P_{ij}(\omega)$, $Q_{ij}(\omega)$, $A_{ij}(\omega)$ and $FEE_{ij}(\omega)$ are then readily formed according to formulae given in (1) and (2). These quantitites for a fixed frequency are then stored for printing routines.

A sample of the print-out is given as Figures 3 and 4. Figure 3 presents the transfer function for an input in the third section and a response in the first section. Each line represents the transfer coefficients for the particular frequency value (ω) in radians/day. Figure 4 presents impulsive response functions including the one for an input in the third section and an output in the first.

The program then proceeds to test whether the amplitude attenuation, $A_{ij}(\omega)$, is less than the tolerance (TOLA). If it is, the remaining values of the transfer function for the higher frequencies are set equal to zero. If $A_{ij}(\omega)$ is greater than the lower bound, an additional test is made to determine whether there are any other frequencies in the set. If there are still some frequencies remaining for which the functions may be evaluated, the ANGLE is computed and the process of evaluating $P_{ij}(\omega)$, $Q_{ij}(\omega)$, $A_{ij}(\omega)$, and the $FEE_{ij}(\omega)$ for this frequency is repeated.

Reverting to the main program, the backward sweep of the response sections is now continued. The previously described criteria determine when the backward sweep stops and the forward sweep begins and when the forward sweep ends.

However, for any input section i as long as any sweep is being made, PQA is called for each response section j. The $A_{ij}(\omega)$ function is computed until for some (ω) it falls below its tolerance TOLA, and the $A_{ij}(\omega)$ for higher values of (ω) are set to zero. Then the values of the impulsive response functions, $k_{ij}(t)$, are computed and the maximum value is found. If this maximum value (BIG) is below its tolerance (TOLKT) the sweep is stopped. If not, then a test is made as to whether the response section is the head of the estuary (backward sweep) or the mouth of the estuary (forward sweep).

INPUT REQUIRED (TRAFNIB)

1. Frequencies to be considered
2. Estuary Matrix

OUTPUT

1. Estuary Matrix
2. Transfer functions for Estuary sections

   (P,Q,A,FEE)

   and the E, F, G, and H polynomial values.
3. Impulsive response functions

Basic Sub-routines (TRAFNIB)

PQA - Computes values of $P_{ij}(\omega)$, $Q_{ij}(\omega)$, $A_{ij}(\omega)$, $FEE_{ij}(\omega)$ e (ω), f (ω) and k(t).

INTEG - Stores the k(t) functions until they are written out.

FORMT, FORMU - Used in evaluating the polynomial tridiagonal matrix

EVALOE - Used in separating and evaluating polynomials necessary for finding $P_{ij}(\omega)$, $Q_{ij}(\omega)$, $A_{ij}(\omega)$, $FEE_{ij}(\omega)$

WRMAT - Routine for writing out matrixes.

Basic Variables

TOLA	-	Tolerance for amplitude attenuation
TOLKT	-	Tolerance for impulsive response functions
MAX	-	Number of sections
P	-	Real part of transfer function, $P_{ij}(\omega)$
Q	-	Imaginary part of transfer function, $Q_{ij}(\omega)$
A	-	Amplitude attenuation, $A_{ij}(\omega)$
FEE	-	Phase shift angle, $FEE_{ij}(\omega)$
E, F, G, H	-	Polynomials used to evaluate P, Q, A, FEE. These correspond to e (ω), f (ω), g (ω) and h (ω) polynomials
BIG	-	Maximum of the impulsive response functions for a section

E. Program Listing for TRAFNIB

```
      PROGRAM  TRAFNIB                                                  FINAL 01
C IF NIB NOT 8, CHANGE CARD  FINAL 121
      DIMENSION FX(35)                                                  FINAL003
      DIMENSION XX(35)                                                  FINAL004
      DIMENSION T(35,33),U(35,33),RM(50,49),SM(50,49),FEEV(50),WN(50),  FINAL005
     2ANGLEV(50),AV(50),B(35),C(35),DET(35),D(35),G(50),GX(35),H(50),   FINAL006
     3HX(35),P(35),PPV(50),Q(35),QQV(50),RTV(50),SQUARE(50),VN(50)      FINAL007
      COMMON T,U,RM,SM,FEEV,ANGLEV,AV,B,C,DET,D,G,GX,H,HX,P,PPV,Q,QQV,  FINAL008
     5RTV,SQUARE,VN,CCC,CONST,DATE,IC,ID,IT,JC,KT,MAX,MAXLIN,MM,NPAGE,  FINAL009
     6 NSKIP,TOLA,TOLKT,XX,LT,LPAGE,WN                                  FINAL010
      IT=2                                                              FINAL011
      KT = 3                                                            FINAL012
      TOLA =.0001                                                       FINAL013
      LT = 6                                                            FINAL014
      NIB = 8                                                           FINAL14A
      REWIND NIB                                                        FINAL14B
      LPAGE = 1                                                         FINAL015
      REWIND LT                                                         FINAL016
      TOLKT =.00003                                                     FINAL017
      PI  = 3.14159246                                                  FINAL018
      CONST = 2.0 * PI/365.0                                            FINAL019
      JJ = 1.0                                                          FINAL020
      CCC = 2.0/PI                                                      FINAL021
      READINPUT TAPE IT,10, VN                                          FINAL022
      READINPUT TAPE IT,10, WN                                          FINAL023
      WRITE OUTPUT TAPE KT,10,VN                                        FINAL024
      WRITE OUTPUT TAPE KT,10,WN                                        FINAL025
   10 FORMAT (14F5.0)                                                   FINAL026
      DO 8 L = 1,50                                                     FINAL027
    8 ANGLEV(L)= CONST * VN(L)                                          FINAL028
      DO 98 K=1,49                                                      FINAL029
      K1 = K+1                                                          FINAL030
      DO 93 I=1,50                                                      FINAL031
      AN = WN(K1) * ANGLEV(I)                                           FINAL032
      RM(K,I)=SINF(AN) / WN(K1)                                         FINAL033
   93 SM(K,I) = ANGLEV(I) * RM(K,I) + COSF(AN) / WN(K1)**2              FINAL034
      DO 97 I=1,49                                                      FINAL035
      RM(K,I) = RM(K,I+1) - RM(K,I)                                     FINAL036
   97 SM(K,I) = SM(K,I+1) - SM(K,I)                                     FINAL037
   98 CONTINUE                                                          FINAL038
C     CALLWRMAT(KT,50,49,6HR MATR, 6HIX     ,6HSIN      ,RM,1,50 )     FINAL039
C     CALLWRMAT(KT,50,49,6HS MATR, 6HIX     ,6HSI-COS   ,SM,1,50 )     FINAL040
      DO 77  LL = 1,15                                                  FINAL041
      MAXLIN = 50                                                       FINAL042
      MM = 1                                                            FINAL043
      NPAGE = 1                                                         FINAL044
      LPAGE = 1                                                         FINAL045
   40 FORMAT (I2,A8,2X,A8)                                              FINAL046
   41 FORMAT (3(10X,F10.4))                                             FINAL047
C  41 FORMAT (3(14X,F6.3))                                             FINAL048
      READ INPUT TAPEIT,40,MAX,ID,DATE                                  FINAL049
      WRITE TAPE NIB,MAX,ID,DATE,P,D,Q                                  FINAL050
      READ INPUT TAPEIT,41,(P(N),D(N),Q(N),N=1,MAX)                     FINAL051
      WRITE OUTPUT TAPE KT,400,MAX,ID,DATE, (P(N),D(N),Q(N),N=1,MAX)    FINAL052
  400 FORMAT(1H1 I5, 10X A8, 5X  A8///  (3F20.4))                       FINAL053
      CALL  FORMT                                                       FINAL053
C     CALL POLOUT (DET,6HTDET.  )                                       FINAL 54
      M2 = MAX + 2                                                      FINAL055
C     CALL WRMAT(KT,M2,MAX,6HT MATR,6HIX     ,ID,T,1,35)                FINAL056
```

```
      CONST = 2.0 * 3.14159246 / 360.0                                  FINAL057
      DO  1    L= 1,50                                                  FINAL058
      ANGLE = CONST * VN(L)                                             FINAL059
      CALL  EVALDE ( OPT, ANGLE, ODD,EVEN)                              FINAL060
      G(L) = EVEN                                                       FINAL061
      H(L) = ODD                                                        FINAL062
    1 SQUARE(L) = EVEN**2 + ODD**2                                      FINAL063
      DO  2     I = 1,MAX                                               FINAL064
    2 B(I) = 0.0                                                        FINAL065
      NPAGE  = 1                                                        FINAL066
      DO 6  N = 1,MAX                                                   FINAL067
      B(N) = 1.0                                                        FINAL069
      CALL FORMU                                                        FINAL070
C     BACKWARD  SWEEP  FROM N  TO AT MOST 1                             FINAL071
      NSKIP = 0                                                         FINAL072
      DO  3    K  = 1,N                                                 FINAL073
      IF (MM) 35,33,35                                                  FINAL074
   33 NPAGE = NPAGE + 1                                                 FINAL075
      MM = 1                                                            FINAL076
   35 J=N+1-K                                                           FINAL077
      CALL MATPOL (U,J,FX)                                              FINAL078
      IF (NSKIP) 4,13,4                                                 FINAL079
   13 CALL PQA (N,FX,J)                                                 FINAL080
    3 CALL INTEG(N,J,JJ,1)                                              FINAL081
      IF (N-MAX) 4,4,6                                                  FINAL082
C     FORWARD SWEEP FROM N+1  TO AT MOST MAX                            FINAL083
    4 NSKIP = 0.0                                                       FINAL084
      N1 = N+1                                                          FINAL085
      DO 5 J = N1, MAX                                                  FINAL086
      IF(MM) 45,43,45                                                   FINAL087
   43 NPAGE = NPAGE + 1                                                 FINAL088
      MM = 1                                                            FINAL089
   45 CALL MATPOL (U,J,FX)                                              FINAL090
      IF (NSKIP) 6,15,6                                                 FINAL091
   15 CALL PQA (N,FX,J)                                                 FINAL092
    5 CALL INTEG(N,J,JJ,1)                                              FINAL093
    6 B(N) = 0.0                                                        FINAL094
      IF (JJ-1) 81,82,81                                                FINAL095
   81 CALL INTEG (N,J,JJ,2)                                             FINAL096
   82 WRITE OUTPUT TAPE KT,400,MAX,ID,DATE,(P(N),D(N),Q(N),N=1,MAX)     FINAL097
      N=0                                                               FINAL 98
      J=0                                                               FINAL98A
      WRITE TAPE NIB,N,J,AV,FEEV,RTV                                    FINAL98B
      END FILE NIB                                                      FINAL98C
   77 PAUSE 77777                                                       FINAL98D
      REWIND NIB                                                        FINAL98E
      READ  TAPE NIB,MAX,ID,DATE,P,D,Q                                  FINAL98F
      READ TAPE NIB,  N,J,AV,FEEV,RTV                                   FINAL98G
      WRITE OUTPUT TAPE KT, 400,MAX,ID,DATE,(P(N),D(N),Q(N),N=1,MAX)    FINAL98H
      WRITE OUTPUT TAPE KT, 6176, N,J, AV,FEEV,RTV                      FINAL98I
 6176 FORMAT (1H1  2I10//(10E12.3))                                     FINAL98J
      REWIND NIB                                                        FINAL98K
      REWIND LT                                                         FINAL100
      END                                                               FINAL101
      SUBROUTINE INTEG(N,J,JJ,NGO)                                      FINAL102
      DIMENSION IV(16),JV(16),FM(50,16)                                 FINAL103
      DIMENSION XX(35)                                                  FINAL104
      DIMENSION T(35,33),U(35,33),RM(50,49),SM(50,49),FEEV(50),VN(50),  FINAL105
     2ANGLEV(50),AV(50),B(35),C(35),DET(35),D(35),G(50),GX(35),H(50),   FINAL106
     3HX(35),P(35),PPV(50),Q(35),QQV(50),RTV(50),SQUARE(50),VN(50)      FINAL107
```

```
      COMMON T,U,RM,SM,FEEV,ANGLEV,AV,B,C,DET,D,G,GX,H,HX,P,PPV,Q,QQV,    FINAL108
     5RTV,SQUARE,VN,CCC,CONST,DATE,IC,ID,IT,JC,KT,MAX,MAXLIN,MM,NPAGE,   FINAL109
     6 NSKIP,TOLA,TOLKT,XX,LT,LPAGE,WN                                   FINAL110
      GO  TO  (1,2) ,  NGO                                               FINAL111
    1 IV(JJ)  =  N                                                       FINAL112
      JV(JJ)   =  J                                                      FINAL113
      DO  3   L=  1,50                                                   FINAL114
    3 FM(L,JJ) = RTV(L)                                                  FINAL115
      IF (JJ-16) 6,4,4                                                   FINAL116
    4 WRITE OUTPUT TAPE LT,5,ID,DATE,LPAGE,IV,JV,(WN(L),(FM(L,M),M=1,16)FINAL117
     1,L=1,50)                                                           FINAL118
    5 FORMAT(1H1 20X 9HESTUARY  A8,5X21HINTEGRAL   COMPUTED   A8,20X     FINAL119
     X1SHINTEGRAL PAGE NO  I3/1H0,5X16I7/1H0,5X16I7//(1H F7.0,16F7.5))   FINAL120
      LPAGE = LPAGE + 1                                                  FINAL121
      WRITE TAPE 8,N,J,AV,FEEV,RTV                                       FINAL121
      JJ = 0.0                                                           FINAL122
    6 JJ = JJ+1                                                          FINAL123
      RETURN                                                             FINAL124
    2 DO 7 J=JJ,16                                                       FINAL125
      IV(J) = 0                                                          FINAL126
      JV(J) = 0                                                          FINAL127
      DO 7 L=1,50                                                        FINAL128
    7 FM(L,J) = 0.0                                                      FINAL129
      GO TO 4                                                            FINAL130
      END                                                                FINAL131
      SUBROUTINE POA (N,ZX,J)                                            FINAL132
      DIMENSION ZX(1)                                                    FINAL133
      DIMENSION FX(35)                                                   FINAL134
      DIMENSION T(35,33),U(35,33),RM(50,49),SM(50,49),FEEV(50),WN(50),   FINAL135
     2ANGLEV(50),AV(50),B(35),C(35),DET(35),D(35),G(50),GX(35),H(50),    FINAL136
     3HX(35),P(35),PPV(50),Q(35),QQV(50),RTV(50),SQUARE(50),VN(50)       FINAL137
      COMMON T,U,RM,SM,FEEV,ANGLEV,AV,B,C,DET,D,G,GX,H,HX,P,PPV,Q,QQV,   FINAL138
     5RTV,SQUARE,VN,CCC,CONST,DATE,IC,ID,IT,JC,KT,MAX,MAXLIN,MM,NPAGE,   FINAL139
     6 NSKIP,TOLA,TOLKT,FX,LT,LPAGE,WN                                   FINAL140
   10 FORMAT(I1,5X45HCALCULATION OF TRANSFER FUNCTION FOR ESTUARY A8,10HFINAL141
     1 FROM THE I2,13H TH INTO THE I2,22H TH SECTION. COMPUTED A8/108X  FINAL142
     2 8HPAGE NO.    I4///                                               FINAL143
     2 1H0,9X5HOMEGA10X1HP12X1HQ12X1HA11X3HFEE11X1HE12X1HF12X1HG12X1HH//)FINAL144
      WRITE OUTPUT TAPE KT,10,MM,ID,J,N,DATE,NPAGE                       FINAL145
      DO  1   L = 1,50                                                   FINAL146
      L1=L+1                                                             FINAL147
      ANGLE = ANGLEV(L)                                                  FINAL148
      NV = VN(L)                                                         FINAL149
      CALL  EVALOE (ZX,ANGLE, F,E  )                                     FINAL150
      PP=(E*G(L) +F*H(L)) /  SQUARE(L)                                   FINAL151
      PPV(L) = PP                                                        FINAL152
      QQ= (F*G(L)- E*H(L))/   SQUARE(L)                                  FINAL153
      QQV(L)=QQ                                                          FINAL154
      A = SQRTF (PP**2 +QQ**2)                                           FINAL155
      AV(L) = A                                                          FINAL156
      CALL ARCSC (QQ,PP,FEE)                                             FINAL157
      FEEV(L) = FEE                                                      FINAL158
      IF (ANGLE) 4,5,4                                                   FINAL159
    4 FEE  = FEE /ANGLE                                                  FINAL160
    5 WRITE OUTPUT TAPE KT,11,NV,ANGLE,PP,QQ,A,FEE,E,F,G(L),H(L)        FINAL161
   11 FORMAT (1H   I4, 2X, F9.4 , 8E13.4 )                               FINAL162
      IF(A-TOLA) 13,13,1                                                 FINAL163
    1 MAXLIN = L                                                         FINAL164
      MAXLIN = 50                                                        FINAL165
      MM = 1                                                             FINAL166
```

```
      GO TO 3                                                          FINAL167
   13 MM = 1                                                           FINAL168
      DO 6 M=L1,50                                                     FINAL169
      PPV(M) = 0.0                                                     FINAL170
      QQV(M) = 0.0                                                     FINAL171
      FEEV(M) = 0.0                                                    FINAL172
    6 AV(M) = 0.0                                                      FINAL173
      IF (MAXLIN-10) 921,3,3                                           FINAL174
  921 MM = 0                                                           FINAL175
    3 NPAGE = NPAGE + MM                                               FINAL176
      DO 59  K = 1,50                                                  FINAL177
   59 RTV(K) = 0.0                                                     FINAL178
      DO 62 I=1,49                                                     FINAL179
      DELAN = ANGLEV(I+1) - ANGLEV(I)                                  FINAL180
      DELP = PPV(I+1) - PPV(I)                                         FINAL181
      AVP = .5*(PPV(I+1) + PPV(I))                                     FINAL182
      RTV(1) =RTV(1)+AVP*DELAN + CCC                                   FINAL183
      RR = (PPV(I)*ANGLEV(I+1) - PPV(I+1)*ANGLEV(I))/DELAN             FINAL184
      SS= DELP/DELAN                                                   FINAL185
      DO 61 K=1,49                                                     FINAL186
      K1=K+1                                                           FINAL187
   61 RTV(K1) = RTV(K1)+RM(K,I)*RR + SM(K,I)*SS                        FINAL188
      RTV(K1) = CCC + RTV(K1)                                          FINAL189
   62 CONTINUE                                                         FINAL190
      BIG = RTV(1)                                                     FINAL191
      DO 63 K=2,50                                                     FINAL192
   63 BIG=MAX1F(BIG,RTV(K))                                            FINAL193
      IF (BIG-TOLRT) 64,64,65                                          FINAL194
   65 IF (MAXLIN-1) 67,64,67                                           FINAL195
   64 NSKIP = 1                                                        FINAL196
   67 RETURN                                                           FINAL197
      END                                                              FINAL198
      SUBROUTINE  FORMU                                                FINAL199
      DIMENSION X(35),Y(35),Z(35)                                      FINAL200
      DIMENSION FX(35)                                                 FINAL201
      DIMENSION T(35,33),U(35,33),RM(50,49),SM(50,49),FEEV(50),WN(50), FINAL202
     2ANGLEV(50),AV(50),B(35),C(35),DET(35),D(35),Q(50),GX(35),H(50),  FINAL203
     3HX(35),P(35),PPV(50),Q(35),QQV(50),RTV(50),SQUARE(50),VN(50)     FINAL204
      COMMON T,U,RM,SM,FEEV,ANGLEV,AV,B,C,DET,D,Q,GX,H,HX,P,PPV,Q,QQV, FINAL205
     5RTV,SQUARE,VN,CCC,CONST,DATE,IC,ID,IT,JC,KT,MAX,MAXLIN,MM,NPAGE, FINAL206
     6 NSKIP,TOLA,TOLRT,FX,LT,LPAGE,WN                                 FINAL207
      U(1,1) = 0.0                                                     FINAL208
      U(2,1) = B(1)                                                    FINAL209
      DO  2    N = 2,MAX                                               FINAL210
      CB   =   B(N)                                                    FINAL211
      CP   =   (-1.0) * P(N-1)                                         FINAL212
      NM1  =   N-1                                                     FINAL213
      CALL  POLSM (T,N,CB,FX)                                          FINAL214
      CALL  POLSM (U, NM1, CP, GX)                                     FINAL215
      CALL  POLS (FX,GX,HX)                                            FINAL216
      CALL POLMAT (HX,N, U)                                            FINAL217
    2 CONTINUE                                                         FINAL218
      M2 = MAX + 2                                                     FINAL219
C     CALL WAMAT(KT,M2,MAX,6HU MATR,6HIX     ,ID,U,1,35)               FINAL220
C     BACKWARD  PASS                                                   FINAL221
      MAX1 = MAX -1                                                    FINAL222
      X(1) =0.0                                                        FINAL223
      X(2) -(-1.0) * B(MAX) *Q(MAX1)                                   FINAL224
      Y(1) = 1.0                                                       FINAL225
      Y(2) = D(MAX)                                                    FINAL226
```

```
      Y(3) = 1.0                                                        FINAL227
      Z(1) = 0.0                                                        FINAL228
      Z(2) = (-1.0) *P(MAX1) * Q(MAX1)                                  FINAL229
      C(1) = 1.0                                                        FINAL230
      C(3) = 1.0                                                        FINAL231
      DO 1 L = 2,MAX                                                    FINAL232
      ML = MAX - L                                                      FINAL233
      ML1 = ML+1                                                        FINAL234
      CALL MATPOL (U,ML1,FX)                                            FINAL235
      CALL POLP (Y,FX,GX)                                               FINAL236
      CALL MATPOL (T,ML1,FX)                                            FINAL237
      CALL POLP (X,FX,HX)                                               FINAL238
      CALL POLS (GX,HX,FX)                                              FINAL239
      CALL POLMAT(FX,ML1,U)                                             FINAL240
      IF(ML)7,1,7                                                       FINAL241
    7 CO=(-1.0)*Q(ML)                                                   FINAL242
      CON = CO * B(ML1)                                                 FINAL243
      CALL POLCON(Y,CON,FX)                                             FINAL244
      CALL POLCON(X,CO,GX)                                              FINAL245
      CALL POLS (FX,GX,X)                                               FINAL246
      C(2) = D(ML1)                                                     FINAL247
      CALL POLP(Y,C,FX)                                                 FINAL248
      CC = (-1.0)*P(ML)*Q(ML)                                           FINAL249
      CALL POLCON (Y,CC,GX)                                             FINAL250
      CALL POLS (Z,FX,Y)                                                FINAL251
      CALL POLCON(GX,1.0,Z)                                             FINAL252
    1 CONTINUE                                                          FINAL253
C     CALL WRMAT(KT,M2,MAX,6HW MATR,6HIX     ,ID,U,1,35)                FINAL254
      RETURN                                                            FINAL255
      END                                                               FINAL256
      SUBROUTINE  FORMT                                                 FINAL257
      DIMENSION FX(35)                                                  FINAL258
      DIMENSION T(35,33),U(35,33),RM(50,49),SM(50,49),FEEV(50),WN(50),  FINAL259
     2ANGLEV(50),AV(50),B(35),C(35),DET(35),D(35),G(50),GX(35),H(50),   FINAL260
     3HX(35),P(35),PPV(50),Q(35),QQV(50),RTV(50),SQUARE(50),VN(50)      FINAL261
      COMMON T,U,RM,SM,FEEV,ANGLEV,AV,B,C,DET,D,G,GX,H,HX,P,PPV,Q,QQV,  FINAL262
     5RTV,SQUARE,VN,CCC,CONST,DATE,IC,ID,IT,JC,KT,MAX,MAXLIN,MM,NPAGE,  FINAL263
     6 NSKIP,TOLA,TOLKT,FX,LT,LPAGE,WN                                  FINAL264
      T(1,1) = 0.0                                                      FINAL265
      T(2,1) = 1.0                                                      FINAL266
      T (1,2) = 1.0                                                     FINAL267
      T(2,2) = D(1)                                                     FINAL268
      T(3,2) = 1.0                                                      FINAL269
      C(1) = 1.0                                                        FINAL270
      C(3) = 1.0                                                        FINAL271
      DET(1) = 1.0                                                      FINAL272
      DET(2) = D(1)                                                     FINAL273
      DET(3) = 1.0                                                      FINAL274
      DO 1  N=2,MAX                                                     FINAL275
      NM1 = N-1                                                         FINAL276
      CF = P(N-1) * Q(N-1) * (-1.0)                                     FINAL277
      N1 = N+1                                                          FINAL278
      C(2)  = D(N)                                                      FINAL279
      CALL  POLP(DET,C,GX)                                              FINAL280
      CALL  POLSM(T,NM1,CF,HX)                                          FINAL281
      CALL  POLS (GX,HX,DET)                                            FINAL282
      CALL  POLMAT(DET,N1,T)                                            FINAL283
    1 CONTINUE                                                          FINAL284
      RETURN                                                            FINAL285
      END                                                               FINAL286
```

```
C $APOL PACK CONTAINS ARCSC,EVALOE,MATPOL,POLCON,POLMAT,POLOUT,POLP,POLSFINAL287
C ,POLSM,WRMAT                                                          FINAL288
      SUBROUTINE ARCSC(SI,CO,A)                                         FINAL289
       PI =3.141592636                                                  FINAL290
      S= SIGNF(PI,SI)                                                   FINAL291
      IF(CO)  3,2,4                                                     FINAL292
    2 A=  .5 *PI                                                        FINAL293
      RETURN                                                            FINAL294
    3 S=0.0                                                             FINAL295
    4  A= ATANF(SI/CO) + PI - S                                         FINAL296
      RETURN                                                            FINAL297
       END                                                              FINAL298
      SUBROUTINE EVALOE ( FX, A , ODD, EVEN)                            FINAL299
      DIMENSION   FX(1)                                                 FINAL300
      N2 = FX(1) +2.0                                                   FINAL301
      FX(N2+1) = 0.0                                                    FINAL302
      FX(N2+2) = 0.0                                                    FINAL303
      FX(N2+3) = 0.0                                                    FINAL304
      ODD = 0.0                                                         FINAL305
      EVEN = 0.0                                                        FINAL306
      Y = 1.0                                                           FINAL307
      DO  1  L = 2,N2, 4                                                FINAL308
      EVEN  = EVEN + FX(L) * Y                                          FINAL309
      Y = Y * A                                                         FINAL310
      ODD   = ODD  +  FX(L+1)*Y                                         FINAL311
         Y  = Y * A                                                     FINAL312
      EVEN  = EVEN- FX(L+2)*Y                                           FINAL313
         Y  = Y * A                                                     FINAL314
      ODD   = ODD  - FX(L+3) *Y                                         FINAL315
    1    Y = Y * A                                                      FINAL316
      RETURN                                                            FINAL317
       END                                                              FINAL318
      SUBROUTINE  MATPOL  (PMAT, JC, GX)                                FINAL319
      DIMENSION  PMAT(35,1) , GX(1)                                     FINAL320
      GX(1) = PMAT(1,JC)                                                FINAL321
      MAX2 = GX(1) + 2.0                                                FINAL322
      DO  1   N=2,MAX2                                                  FINAL323
    1 GX (N)= PMAT(N,JC)                                                FINAL324
      RETURN                                                            FINAL325
       END                                                              FINAL326
      SUBROUTINE POLCON (FX,CC,GX)                                      FINAL327
      DIMENSION FX(1),GX(1)                                             FINAL328
      NF2 = FX(1) +2.0                                                  FINAL329
      DO 1 L = 2,NF2                                                    FINAL330
    1 GX(L) = CC * FX(L)                                                FINAL331
      IF (CC)  2, 3, 2                                                  FINAL332
    2 GX(1) = FX(1)                                                     FINAL333
      RETURN                                                            FINAL334
    3 GX(1) = 0.0                                                       FINAL335
       END                                                              FINAL336
      SUBROUTINE  POLMAT(GX,JC,PMAT)                                    FINAL337
      DIMENSION  PMAT(35,1),        GX(1)                               FINAL338
      PMAT (1,JC) = GX(1)                                               FINAL339
      MAX2  =  GX(1)  +2.0                                              FINAL340
      DO  1  N=2, MAX2                                                  FINAL341
    1 PMAT (N,JC) = GX(N)                                               FINAL342
      RETURN                                                            FINAL343
       END                                                              FINAL344
      SUBROUTINE POLOUT(FX,ID)                                          FINAL345
      DIMENSION FX(1),TX(70),NPL(70)                                    FINAL345
```

```
      KT=3                                                                  FINAL347
      JF2=FX(1)+2.0                                                         FINAL348
      L=1                                                                   FINAL349
      DO 2 N=2,JF2                                                          FINAL350
      NP=JF2-N+2                                                            FINAL351
      IF(FX(NP)) 1,2,1                                                      FINAL352
    1 TX(L)=FX(NP)                                                          FINAL353
      NPL(L)=NP-2                                                           FINAL354
      L=L+1                                                                 FINAL355
    2 CONTINUE                                                              FINAL356
      MAX=L-1                                                               FINAL357
      WRITE OUTPUT TAPE KT,10,ID,(TX(L),NPL(L),L=1,MAX)                     FINAL358
   10 FORMAT(12HOPOLYNOMIAL A6,2H =,5(2H+(E10.4,5H X ** I2, 1H)) /          FINAL359
     1                              (6(2H+(E10.4,5H X ** I2, 1H))))        FINAL360
C    1                               6(2H+(E10.4,5H X ** I2, 1H)))         FINAL361
      RETURN                                                                FINAL362
       END                                                                  FINAL363
      SUBROUTINE POLP(FX,GX,PX)                                             FINAL364
      DIMENSION FX(1),GX(1),PX(1)                                           FINAL365
      PX(1)=FX(1)+GX(1)                                                     FINAL366
      JP2=PX(1)+2.0                                                         FINAL367
      JF3=FX(1)+3.0                                                         FINAL368
      JG3=GX(1)+3.0                                                         FINAL369
      DO 1 N=JF3,JP2                                                        FINAL370
    1 FX(N)=0.0                                                             FINAL371
      DO 2 N=JG3,JP2                                                        FINAL372
    2 GX(N)=0.0                                                             FINAL373
      DO 4 N=2,JP2                                                          FINAL374
      PX(N)=0.0                                                             FINAL375
      DO 3 L=2,N                                                            FINAL376
      NL2=N-L+2                                                             FINAL377
    3 PX(N)=PX(N)+FX(L)*GX(NL2)                                             FINAL378
    4 CONTINUE                                                              FINAL379
      RETURN                                                                FINAL380
       END                                                                  FINAL381
      SUBROUTINE POLS (FX,GX,SX)                                            FINAL382
      DIMENSION FX(1),GX(1),SX(1)                                           FINAL383
      SX(1) = MAX1F(FX(1),GX(1))                                            FINAL384
      JS2 = SX(1)+2.0                                                       FINAL385
      JF3 = FX(1)+3.0                                                       FINAL386
      JG3 = GX(1)+3.0                                                       FINAL387
      DO 1 N=JF3,JS2                                                        FINAL388
    1 FX(N)=0.0                                                             FINAL389
      DO 2 N=JG3,JS2                                                        FINAL390
    2 GX(N)=0.0                                                             FINAL391
      DO 3 N=2,JS2                                                          FINAL392
    3 SX(N) = FX(N)+GX(N)                                                   FINAL393
      RETURN                                                                FINAL394
       END                                                                  FINAL395
      SUBROUTINE  POLSM(PMAT, JC, C, GX)                                    FINAL396
      DIMENSION  PMAT(35,1),       GX(1)                                    FINAL397
      GX(1) = PMAT(1,JC)                                                    FINAL398
      MAX2  =  GX(1)  +2.0                                                  FINAL399
      DO  1  N=2, MAX2                                                      FINAL400
    1 GX(N)  =  C  *  PMAT(N,JC)                                            FINAL401
      IF (C) 3, 2, 3                                                        FINAL402
    2 GX(1) = 0.0                                                           FINAL403
    3 RETURN                                                                FINAL404
       END                                                                  FINAL405
      SUBROUTINE  #RMAT  (NTAPE,NR, NC,BCD1,BCD2,IDENT, U,NTEST, NRDIM)     FINAL406
```

```
      DIMENSION   U(1),JK(10)                                                    FINAL407
  100 FORMAT  (1H1,56X,A6/1H0,53X,A6,A6/1H0 10(8X I3))                          FINAL408
  200 FORMAT  (1H )                                                             FINAL409
  300 FORMAT(1H I3,1X,1P10E11.3,2X,I3)                                          FINAL410
      DO 11  J = 1, NC, 10                                                      FINAL411
      DO 2   M = 1, 10                                                          FINAL412
    2 JK(M) = J + M + NTEST  - 2                                                FINAL413
      DO 11   I =  1, NR                                                        FINAL414
   18  IJ  =  NRDIM*(J-1) + I                                                   FINAL415
        IJP9  =  NRDIM *(J+8)  + I                                              FINAL416
      IJNC = NRDIM *(NC-1)  +I                                                  FINAL417
      JMAX=MINOF(10,NC-J+1)                                                     FINAL418
        IR1   =  I -  1+ NTEST                                                  FINAL419
        IM1   =  I -  1                                                         FINAL420
      IF ( XMODF(IM1,50))   3, 3, 4                                             FINAL421
    3 WRITE  OUTPUT TAPE NTAPE,100,IDENT, BCD1, BCD2,(JK(M),M=1,JMAX)           FINAL422
    4 IF (XMODF (IM1,10))   7,7,10                                              FINAL423
    7 WRITE  OUTPUT TAPE NTAPE, 200                                             FINAL424
   10 IF  (IJP9 - IJNC)   30,30,20                                              FINAL425
   30 WRITE OUTPUT TAPE NTAPE,300, IR1,(U(K),K=IJ,IJP9,NRDIM),IR1               FINAL426
      GO TO 11                                                                  FINAL427
   20 WRITE OUTPUT TAPE NTAPE,300, IR1,(U(K),K=IJ,IJNC,NRDIM)                   FINAL428
   11     CONTINUE                                                            FINAL429
      RETURN                                                                    FINAL430
      END                                                                       FINAL431
       END                                                                      FINAL432
    .   1.   2.   3.   4.   5.   6.   7.   8.   9.  10.  11.  12.  13.
  14.  15.  16.  17.  18.  19.  20.  21.  22.  23.  24.  25.  26.  27.
  28.  29.  30.  31.  32.  33.  34.  35.  52.  70.  90. 110. 150. 200.
 250. 300. 360. 500. 705. 730.1000.1460.
    .   1.   2.   3.   4.   5.   6.   7.   8.   9.  10.  11.  12.  13.
  14.  15.  16.  17.  18.  19.  20.  21.  22.  23.  24.  25.  26.  27.
  28.  29.  30.  35.  40.  45.  50.  55.  60.  65.  70.  75.  80.  85.
  90.  95. 100. 110. 120. 130. 140. 150.
```

FIGURE THREE

Sample Output - P, Q, A, FEE

Reproduced from best available copy.

CALCULATION OF TRANSFER FUNCTION FOR ESTUARY JVBEST FROM THE 3 TH INTO THE 1 TH SECTION. COMPUTED FEB 83

FIGURE THREE

	OMEGA	P	Q	A	FEE	E	F	G	H
0	.0000	.6687E+00	.0000E+00	.6687E+00	.0000E+00	.1159E+00	.0000E+00	.1733E+00	.0000E+00
1	.0172	.6658E+00	-.5371E-01	.6679E+00	.3603E+03	.1159E+00	.3393E-02	.1726E+00	.1932E-01
2	.0344	.6570E+00	-.1066E+00	.6656E+00	.1778E+03	.1159E+00	.6786E-02	.1703E+00	.3795E-01
3	.0516	.6426E+00	-.1579E+00	.6618E+00	.1170E+03	.1159E+00	.1018E-01	.1664E+00	.5573E-01
4	.0689	.6230E+00	-.2069E+00	.6564E+00	.8659E+02	.1159E+00	.1357E-01	.1611E+00	.7526E-01
5	.0861	.5985E+00	-.2528E+00	.6497E+00	.6836E+02	.1159E+00	.1697E-01	.1542E+00	.9347E-01
6	.1033	.5698E+00	-.2953E+00	.6417E+00	.5620E+02	.1159E+00	.2036E-01	.1456E+00	.1113E+00
7	.1205	.5373E+00	-.3337E+00	.6325E+00	.4753E+02	.1159E+00	.2375E-01	.1359E+00	.1286E+00
8	.1377	.5018E+00	-.3677E+00	.6221E+00	.4103E+02	.1159E+00	.2715E-01	.1245E+00	.1453E+00
9	.1549	.4639E+00	-.3972E+00	.6107E+00	.3598E+02	.1159E+00	.3054E-01	.1116E+00	.1614E+00
10	.1721	.4243E+00	-.4220E+00	.5985E+00	.3195E+02	.1159E+00	.3393E-01	.9733E-01	.1768E+00
11	.1894	.3836E+00	-.4422E+00	.5854E+00	.2866E+02	.1159E+00	.3733E-01	.8159E-01	.1913E+00
12	.2066	.3425E+00	-.4577E+00	.5717E+00	.2592E+02	.1159E+00	.4072E-01	.6444E-01	.2050E+00
13	.2238	.3015E+00	-.4689E+00	.5575E+00	.2361E+02	.1159E+00	.4411E-01	.4591E-01	.2177E+00
14	.2410	.2612E+00	-.4759E+00	.5428E+00	.2164E+02	.1159E+00	.4751E-01	.2631E-01	.2295E+00
15	.2582	.2218E+00	-.4789E+00	.5278E+00	.1993E+02	.1159E+00	.5090E-01	.4786E-02	.2398E+00
16	.2754	.1839E+00	-.4785E+00	.5126E+00	.1844E+02	.1159E+00	.5429E-01	-.1774E-01	.2490E+00
17	.2926	.1477E+00	-.4748E+00	.4973E+00	.1713E+02	.1159E+00	.5768E-01	-.4153E-01	.2570E+00
18	.3099	.1135E+00	-.4683E+00	.4819E+00	.1598E+02	.1159E+00	.6108E-01	-.6655E-01	.2635E+00
19	.3271	.8132E-01	-.4594E+00	.4665E+00	.1494E+02	.1159E+00	.6447E-01	-.9278E-01	.2687E+00
20	.3443	.5140E-01	-.4483E+00	.4513E+00	.1402E+02	.1159E+00	.6786E-01	-.1202E+00	.2723E+00
21	.3615	.2378E-01	-.4355E+00	.4361E+00	.1319E+02	.1159E+00	.7126E-01	-.1486E+00	.2743E+00
22	.3787	-.1529E-02	-.4212E+00	.4212E+00	.1243E+02	.1159E+00	.7465E-01	-.1782E+00	.2745E+00
23	.3959	-.2454E-01	-.4058E+00	.4066E+00	.1175E+02	.1159E+00	.7804E-01	-.2086E+00	.2730E+00
24	.4131	-.4530E-01	-.3896E+00	.3922E+00	.1113E+02	.1159E+00	.8144E-01	-.2404E+00	.2696E+00
25	.4303	.5140E-01	-.4483E+00	.4513E+00	.1402E+02	.1159E+00	.6786E-01	-.1202E+00	.2723E+00
26	.4476	-.8038E-01	-.3555E+00	.3644E+00	.1003E+02	.1159E+00	.8822E-01	-.3063E+00	.2568E+00
27	.4648	-.9490E-01	-.3380E+00	.3511E+00	.9550E+01	.1159E+00	.9162E-01	-.3405E+00	.2473E+00
28	.4820	-.1076E+00	-.3205E+00	.3381E+00	.9105E+01	.1159E+00	.9501E-01	-.3755E+00	.2355E+00
29	.4992	-.1185E+00	-.3032E+00	.3255E+00	.8694E+01	.1159E+00	.9840E-01	-.4112E+00	.2216E+00
30	.5164	-.1278E+00	-.2861E+00	.3133E+00	.8312E+01	.1159E+00	.1018E+00	-.4475E+00	.2053E+00
31	.5336	-.1355E+00	-.2693E+00	.3015E+00	.7957E+01	.1159E+00	.1052E+00	-.4844E+00	.1869E+00
32	.5509	-.1420E+00	-.2530E+00	.2901E+00	.7626E+01	.1159E+00	.1086E+00	-.5219E+00	.1663E+00
33	.5681	-.1471E+00	-.2372E+00	.2791E+00	.7318E+01	.1159E+00	.1120E+00	-.5598E+00	.1436E+00
34	.5853	-.1512E+00	-.2219E+00	.2685E+00	.7030E+01	.1159E+00	.1154E+00	-.5981E+00	.1188E+00
35	.6025	-.1542E+00	-.2072E+00	.2583E+00	.6760E+01	.1159E+00	.1188E+00	-.6367E+00	.8547E-01
52	.8951	-.1265E+00	-.4806E-01	.1353E+00	.3915E+01	.1159E+00	.1764E+00	-.1264E+01	-.9146E+00
70	1.2050	-.7275E-01	.2361E-02	.7277E-01	.2580E+01	.1159E+00	.2375E+00	-.1486E+01	-.3313E+01
90	1.5493	-.3789E-01	.1284E-01	.4000E-01	.1417E+01	.1159E+00	.3054E+00	-.2930E+00	-.5150E+01
110	1.8936	-.2060E-01	.1201E-01	.2389E-01	.8472E+00	.1159E+00	.3733E+00	.3727E+01	-.1503E+02
150	2.5821	-.7217E-02	.7307E-02	.1027E-01	.3641E+00	.1159E+00	.5090E+00	.3314E+02	-.4289E+02
200	3.4428	-.2530E-02	.3768E-02	.4539E-02	.6280E+00	.1159E+00	.6786E+00	.2490E+03	-.1[illegible]
250	4.3036	-.1088E-02	.2112E-02	.2376E-02	.4755E+00	.1159E+00	.8483E+00	.[illegible]	.[illegible]
300	5.1643	-.5387E-03	.1283E-02	.1392E-02	.3811E+00	.1159E+00	.1018E+01	.[illegible]	.[illegible]
365	6.2832	-.2508E-03	.7383E-03	.7797E-03	.3021E+00	.1159E+00	.1239E+01	.[illegible]	.[illegible]
500	8.6071	-.7260E-04	.2973E-03	.3060E-03	.2103E+00	.1159E+00	.1597E+01	.5[illegible]	-.1581E+04
705	12.1360	-.1857E-04	.1081E-03	.1097E-03	.1434E+00	.1159E+00	.2302E+01	.2131E+05	-.4732E+04
730	12.5664	-.1617E-04	.9753E-04	.9886E-04	.1381E+00	.1159E+00	.2477E+01	.2453E+05	-.5255E+04

FIGURE FOUR

Sample Output for Impulsive
Response Functions

FIGURE FOUR ESTUARY C.C.B. INTEGRAL COMPUTED NOV.63 ↓ INTEGRAL PAGE NO 3

INPUT SECTION	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3
RESPONSE SECTION	14	15	16	17	18	19	20	3	2	1	4	5	6	7	8	9
0.	.00005	.00001	-.00000	.00000	.00000	.00000	-.00000	.99171	.00389	.00004	.01443	-.00001	-.00118	-.00118	-.00035	-.00052
1.	.00006	.00002	.00000	.00001	.00001	.00000	-.00000	.59453	.02080	.00035	.38059	.08875	.01038	.00371	-.00075	-.00072
2.	.00002	.00001	.00000	.00000	.00000	.00000	-.00000	.31460	.01584	.00127	.34615	.16482	.04373	.01411	.00475	.00129
3.	-.00003	-.00000	.00000	.00000	.00000	.00000	-.00000	.14449	.01052	.00103	.24017	.17562	.07186	.03259	.01559	.00655
4.	-.00005	-.00001	.00001	-.00000	-.00000	-.00000	-.00000	.05713	.00596	.00067	.15018	.15034	.08323	.04654	.02584	.01377
5.	.00003	-.00000	.00001	-.00000	-.00000	-.00000	-.00000	.03293	.00331	.00040	.09082	.11441	.08007	.05228	.03441	.02033
6.	.00024	.00005	.00001	-.00000	-.00000	-.00000	-.00000	.01836	.00183	.00023	.05415	.08188	.06916	.05092	.03701	.02432
7.	.00059	.00014	.00003	.00000	-.00000	-.00000	.00000	.00579	.00105	.00014	.03357	.05790	.05580	.04514	.03554	.02554
8.	.00103	.00029	.00006	.00001	-.00000	-.00000	.00000	.00532	.00060	.00008	.01986	.03847	.04272	.03772	.03132	.02455
9.	.00148	.00047	.00011	.00003	.00000	.00000	.00000	.00283	.00035	.00005	.01197	.02515	.03149	.03018	.02712	.02249
10.	.00186	.00067	.00019	.00005	.00001	.00000	.00000	.00344	.00016	.00002	.00529	.01557	.02249	.02345	.02237	.01773
11.	.00218	.00086	.00027	.00008	.00002	.00001	.00000	.00367	.00033	.00000	.00237	.00815	.01552	.01790	.01811	.01682
12.	.00234	.00102	.00036	.00012	.00004	.00001	-.00001	-.00054	-.00004	-.00000	-.00028	.00378	.01048	.01341	.01431	.01392
13.	.00242	.00115	.00045	.00015	.00005	.00001	-.00001	-.00078	-.00007	-.00001	-.00027	.00132	.00732	.00987	.01133	.01111
14.	.00241	.00124	.00052	.00019	.00006	.00002	-.00001	-.00115	-.00006	-.00001	-.00035	.00054	.00483	.00707	.00899	.00843
15.	.00232	.00127	.00057	.00022	.00008	.00003	-.00001	-.00144	-.00003	-.00000	-.00037	.00026	.00345	.00477	.00652	.00651
16.	.00215	.00125	.00059	.00025	.00009	.00003	.00001	-.00139	.00004	.00001	.00029	.00218	.00227	.00287	.00345	.00407
17.	.00192	.00118	.00060	.00027	.00011	.00004	.00001	.00080	.00012	.00001	.00283	.00206	.00111	.00153	.00210	.00278
18.	.00166	.00108	.00059	.00028	.00012	.00004	.00002	.00232	.00018	.00001	.00265	.00092	.00042	.00094	.00149	.00207
19.	.00140	.00097	.00056	.00029	.00012	.00005	.00002	.00264	.00024	.00000	.00068	.00025	.00050	.00097	.00134	.00170
20.	.00115	.00084	.00052	.00028	.00013	.00005	.00002	-.00151	-.00008	-.00001	-.00148	-.00018	.00031	.00117	.00134	.00148
21.	.00094	.00072	.00047	.00027	.00013	.00006	.00002	-.00125	-.00011	-.00001	-.00230	-.00077	.00072	.00112	.00123	.00125
22.	.00076	.00061	.00042	.00025	.00013	.00006	.00002	-.00359	-.00005	-.00001	-.00124	-.00382	.00029	.00072	.00093	.00096
23.	.00062	.00051	.00036	.00023	.00013	.00006	.00002	.00036	.00001	-.00000	-.00002	-.00039	-.00008	.00024	.00044	.00060
24.	.00050	.00042	.00031	.00021	.00012	.00005	.00002	.00042	.00004	.00000	.00008	.00022	-.00019	-.00008	.00004	.00028
25.	.00041	.00035	.00027	.00018	.00011	.00006	.00002	.00053	.00004	.00000	.00002	.00047	-.00009	-.00014	-.00005	.00003
26.	.00033	.00029	.00023	.00016	.00010	.00006	.00002	.00015	.00002	.00000	.00005	.00024	.00008	-.00004	-.00004	.00003
27.	.00025	.00023	.00019	.00014	.00009	.00005	.00002	-.00021	.00000	.00000	.00013	.00033	.00017	.00008	.00004	.00006
28.	.00019	.00019	.00016	.00012	.00008	.00005	.00002	.00000	-.00001	-.00000	-.00017	.00004	.00016	.00014	.00011	.00010
29.	.00015	.00015	.00013	.00010	.00007	.00004	.00002	-.00018	-.00001	-.00000	-.00013	-.00004	.00009	.00012	.00012	.00011
30.	.00011	.00012	.00010	.00008	.00006	.00004	.00002	.00003	.00000	.00000	-.00012	-.00011	.00002	.00007	.00010	.00010
31.	.00008	.00009	.00008	.00006	.00005	.00003	.00002	.00004	-.00001	.00000	-.00007	-.00006	.00000	.00003	.00007	.00008
32.	.00006	.00007	.00006	.00005	.00004	.00003	.00002	.00004	.00000	.00000	-.00003	-.00002	-.00000	.00001	.00004	.00006
33.	.00004	.00005	.00005	.00004	.00003	.00002	.00002	.00003	.00000	.00000	-.00001	-.00000	.00000	.00000	.00002	.00004
34.	.00003	.00004	.00003	.00003	.00002	.00002	.00001	.00002	.00000	.00000	.00000	.00000	.00000	.00000	.00001	.00003
35.	.00002	.00003	.00002	.00002	.00002	.00001	.00001	.00001	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00002
36.	.00001	.00002	.00002	.00001	.00001	.00001	.00001	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00001
37.	.00001	.00001	.00001	.00001	.00001	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00001
38.	.00000	.00001	.00001	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
39.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
40.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
41.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
42.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
43.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
44.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
45.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
46.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
47.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
48.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
49.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
50.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
51.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
52.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
53.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
54.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
55.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
56.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
57.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
58.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
59.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
60.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
61.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
62.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
63.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
64.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
65.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
66.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
67.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
68.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
69.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
70.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
71.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
72.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
73.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
74.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
75.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
76.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
77.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
78.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
79.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
80.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
81.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
82.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
83.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
84.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
85.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
86.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
87.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
88.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
89.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
90.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
91.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
92.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
93.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
94.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
95.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
96.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
97.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
98.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
99.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
100.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
110.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
120.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
130.	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000	.00000
140.	-.00000	-.00000	-.00000	.00000	-.00000	.00000	.00000	.00000	-.00000	-.00000	-.00000	.00000	.00000	.00000	.00000	.00000
150.	-.00000	.00000	.00000	.00000	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000	-.00000	.00000	.00000	.00000	.00000	.00000

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